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AUTHOR	Nelson, C. Riley; Hanegan, Nikki L.
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ABSTRACT

This paper discusses an intensive professional development program designed by a science education specialist in conjunction with university science research professors demonstrating quality science teaching practices for secondary teachers in a contextual setting. The intensive professional development model was designed using research based, effective practices through field science experiences which included: (1) Curriculum developed and aligned with the Benchmarks and Standards for grades 9-12; (2) a focus on teaching through unified science concepts and processes; (3) the utilization of science process skills in contexts; (4) participation in science investigations via contextual hands-on experiences and open ended activities; (5) extensive use of cooperative group learning; (6) enhancement of teacher's science context beyond grade 9-12 standards; (7) participation in long term science research projects with a science researcher; and (8) participation in teaching learning communities. After the implementation of the intensive professional development program, an investigation was conducted using qualitative methods to determine how secondary teachers' teaching practices were impacted as a result of university science research professors demonstrating teaching practices in a contextual setting. The findings reported that the professional development model implemented did have a positive impact on the teachers' teaching practices, resulting in more student-centered instruction and an increase in student learning expectations. (Author)

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Professional Development for Secondary Science Teachers In a Contextual Setting

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C. Riley Nelson and Nikki L. Hanegan

"It is now widely accepted that… all teachers will have to unlearn much of what they believe, know, and know how to do while also forming new beliefs, developing new knowledge, and mastering new skills. The proposed reforms constitute, if you will, a new curriculum for teacher learning" (Thompson and Zeuli, 1999).

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This paper discusses an intensive professional development program designed by a science education specialist in conjunction with university science research professors demonstrating quality science teaching practices for secondary teachers in a contextual setting. The intensive professional development model was designed using research based, effective practices through field science experiences which included:

1) **curriculum developed and aligned with the *Benchmarks and Standards* for grades 9-12,**
2) **a focus on teaching through unified science concepts and processes,**
3) **the utilization of science process skills in context,**
4) **participation in science investigations via contextual hands-on experiences and open ended activities,**
5) **extensive use of cooperative group learning,**
6) **enhancement of teacher's science content beyond grade 9-12 standards,**
7) **participation in long term science research projects with a science researcher, and**
8) **participation in teacher learning communities.**

After the implementation of the intensive professional development program, an investigation was conducted using qualitative methods to determine how secondary teachers' teaching practices were impacted as a result of university science research professors demonstrating the above teaching practices in a contextual setting. The findings reported that the professional development model implemented did have a positive impact on the teachers' teaching practices, resulting in more student-centered instruction and an increase in student learning expectations.

Introduction

Most teachers receive information about best teaching practices in science education. However, several research studies have found that teachers do not implement directly effective teaching practices that are supported by education research unless they first question their teacher belief systems. It has been determined that teachers' belief

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systems most resistant to change are teacher expectations, teacher identities, and student learning expectations (van Driel, Beijaard, Verloop, 2001; Kennedy, 1997).

According to the National Science Education Standards, "changing the pedagogical practices of higher education is a necessary condition for changing pedagogical practices in K-12 schools" (NRC, 2001; p.226). How can we expect the reform of pedagogical practices in higher education if higher education has no knowledge of what effective teaching practices are for K-12 schools? Higher education must become directly involved in K-12 professional development, not just as science content experts, but also to model effective teaching practices. Higher education faculty need reciprocal professional development through interaction with science education specialists and teachers in order to learn what teachers need to be able to teach pre-college students through interactions in intensive programs.

Purpose of Study/Needs Assessment

The purpose of this longitudinal investigation was to immerse secondary science teachers in a professional development model and determine if the model changed teaching practices. The model incorporated effective teaching practices consistent with science education reform in contextual settings enabling the teachers to construct similar, relevant experiences to meet the needs of their individual students. A mixed method approach was employed using Naturalistic Inquiry in phase one and followed by a quantitative tool designed after all themes had been developed (Lincoln and Guba, 1985). The tool was employed to determine how much change the teacher believe occurred. After the quantitative tool was analyzed, classroom observation tools designed to validate the use of inquiry teaching practices as reported by the teachers were used. This mixed methodology was chosen to capture the teachers' changes and to develop tools for random selection of teachers in the second generation of this investigation.

We had several needs based on information collected from educators in the Southwest Region. How can rural high school science teachers be meaningfully engaged in a continual professional learning community, such as lesson study? How can science research faculty with no knowledge of critical education issues assist with teachers' science content knowledge? If science faculty model effective teaching practices, will this help change teachers' belief systems about themselves as science educators? Can we train high school teachers in low socio-economic schools to use their natural surroundings for rich science learning and experiences for their students? Will this experience change the science research faculty beliefs about how they teach their college students? While these questions were designed to look at "yes" or "no" answers, we also wanted to begin examining ways that we could measure the amount of change. Also we wanted to possibly record where change occurred, how much intensity was necessary to make change occur, determine if these changes would be self-sustaining, and could this help build capacity for other teachers in the school to change?

Theoretical Framework

Components of Intensive Field Science

Intensive field science professional development for teachers suggests several strategies (ENC, 1999). They can be lengthy, content rigorous, contextual experiences, with the classroom or school serving as the field. However, in this investigation, intensive field science professional development was more refined, immersing the participants (in-service science teachers and higher education science faculty) in a six month program involving over 60 direct contact hours and approximately 40 independent study hours each year. The immersion began with five days of summer instruction in an institute that capitalized on outdoor settings as the field or contextual environment. The participants were studied through the fall semester as they applied the model into their classrooms. A two-fold emphasis was designed into the model to increase science content knowledge and reshape teachers' beliefs about science pedagogy content knowledge through direct application in their classrooms (Elmore, 2000).

Professional Development in a Contextual Setting

> "*Science for All Americans* is based on the belief that the science-literate person is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes" (Rutherford, 1990).

When a teacher searches for professional development programs, he/she still finds most offerings consist of a two to six hour workshop or seminar. Workshops and seminars tend to be offered for short periods of time for discrete learning goals, such as how to use a new assessment strategy (Loucks-Horsley, 1998; TIMSSR, 2001). Sometimes, the teacher may find a professional development program that spans an entire day of activities. Rural teachers especially have difficulty obtaining quality professional development programs that are easily accessible and affordable. Even fewer quality professional development programs are designed for rural secondary high school science teachers and often, the best professional development opportunities for these teachers are found at state, regional, and national conferences. By design, these professional development programs cannot incorporate nor model numerous effective professional development strategies, indicating that few rural teachers have the opportunity to be immersed in quality professional development programs.

Quality science professional development programs are designed according to the standards for professional development outlined by the National Science Education Standards. Those standards include both content (what teachers need to learn) and pedagogy (how teachers should teach) (Rhoton & Bowers, 2001). The standards call for teachers to learn and teach for deep understanding of science concepts through active investigations significant to their interests and building on their prior knowledge. The professional standards express that teachers should apply their knowledge of science concepts through inquiry, reflection, interpretation of research, modeling, and guided practices. Quality professional development, according to the standards, should also build communities to support teachers as lifelong learners through sustained, comprehensive learning known as intensive professional development involving 100

contact clock hours or more. Some higher education faculty members are beginning to study and use the standards for effective teaching practices in their college courses to better prepare pre-service teachers. The premise is that if pre-service teachers are taught through more effective teaching practices in their college courses, they will teach similarly in the K-12 setting (Seibert and McIntosh, 2001).

Professional developers should assist teachers with their practical work, (ie; science standards, student outcomes, standardized assessments that often conflict with science education reform goals, institutional infrastructure, teachers' resistance to change, curriculum that is not aligned with the science standards and Benchmarks and Standards). These and other education issues will not disappear as they are deeply rooted in political and social systems. Rather than ignoring teachers' practical work, professional developers need to assist teachers with the implementation of reform teaching practices within the constraints of the education system. Without addressing teachers' daily practice concerns in professional development programs, there is little hope that professional development will have an impact on current teaching practices, as teachers' practical work is central to their jobs. As education researcher, Vartan Gregorian states, "We say that higher education should be more involved in public schools. Unfortunately, we tend to know very little about them" (Chronicle of Higher Education, 2001). Many professional developers and science education researchers are faculty of higher education and so they, too, may know little about K-12 school settings.

A second contextual setting that is a necessary consideration for science professional development programs concerns not pedagogy but content. When young students and the general population are asked, "Where does science occur?", the most common response is "in laboratories." Most students and the general population fail to realize that many scientists use what has been captured in the natural world in their research. Most scientific research laboratories are designed to conduct experiments to attempt to control what has been observed in nature.

Science is defined as the study of nature; however, curriculum is opften developed to teach science without studying nature. Although it may be a difficult task, teaching for meaning, connections, and context is more desirable for students than teaching fragmented facts and the history of science (Rutherford, 1990). One of John Dewey's most profound statements was his argument that public schools could nurture the "risky, adventurous, quirky learning that Twain had found on the river" (Cohen, 1988 referring to Mark Twain's characters). This did not mean that science must be taught through our current vision of field trips. Rather, teachers can use their natural surroundings, their local rivers, woods, outcrops, or wetlands, to teach conceptual understandings of science. The school and community surroundings provide students with relevant hands-on learning opportunities to study nature or science. Yet, too few teachers have the capacity to use nature as their laboratory and combine the principles of biology, the physical sciences and mathematics to study the natural environment because of the limitations of their pre-service teacher preparation.

> "Because of the way in which school subjects are organized, the courses these teachers become responsible to teach are frequently beyond the scope of their college disciplinary specialization. Science teachers teach earth science, physical science, biology, health...Yet, as university students, prospective science and social studies teachers major in a single science-chemistry, physics, or biology, for example-...As

teachers, what they understand about topics outside their specialization is likely based on what they remember from elementary and high school classes" (Ball, 1997).

Intensive Field Science Professional Development Model

The Southwest Consortia for Improvement of Mathematics and Science Teaching (SCIMAST) model was designed and developed collaboratively with two university science research faculty members and one science education specialist. The intensive field science experiences were designed to improve discipline content knowledge through rich contextual experiences and pedagogical knowledge. The professional development model was implemented twice in two separate locations, one in West Texas and another in Albuquerque, New Mexico.

The professional development model was designed to teach one thematic science issues critical for science literacy as identified in the *Benchmarks and Standards* and executed through field science experiences. The program in West Texas was facilitated by a science professor whose expertise includes desert stream ecology and was focused around the thematic benchmark "Interdependence of Life." The New Mexico program was conducted with a different science professor whose expertise included the geological processes of the Rio Grande Rift Basin surrounding Albuquerque and used the thematic benchmark "Constancy and Change."

The Investigation

During the first semester of implementing instruction using the thematic benchmark learned during the summer, teachers were investigated to determine how the professional development experience changed their teaching practices. All emergent data was collected, transcribed, and coded for theme development. Twenty-two teachers participated in the professional development model. Twenty teachers participated in the teacher interviews. However, only 17 teachers participated in the full investigation to determine influence on teaching practices. Sixteen teachers completed the survey for statistical analysis. The five teachers that did not fully participate in the study, voluntarily dropped out of the program stated their reasons for not completing the fall follow up activities resulted from their self perception of not teaching life or earth sciences in the fall. This was not one of the determined criteria by the investigators.

Data Collection

Phase one of the investigation used Naturalistic Inquiry methods. A wide variety of data were collected for triangulation purposes to check for saturation and accuracy of reporting. Although diverse data were collected and checked by the respondents, this study may be limited because all data collected were instruments of self-reporting in this phase. The following data items were collected and coded for thematic development.

1) Open-ended evaluations immediately following the summer institute. The prompt question used was: "What did you learn this week that you think will be useful to your work in your classroom?"
2) Submission of action plans: action plans were submitted through the list-serve two weeks after school began. Each teacher was requested to give a response to this open-ended prompt: "What do you plan to do in your classroom to implement the benchmark used in the summer institute?"
3) List-serve submissions: The teachers were asked to submit at least one short summary of what was occurring in their classroom while implementing their action plans.
4) Emergent interviews: Two emergent interviews were conducted with the teachers. One interview was conducted during the implementation of their action plans, and the second interview was conducted after the completion of their action plans. The open-ended prompts for both interviews were: "What is happening (or did happen) in your classroom? Discuss any challenges, rewards, or things you would do differently."

Phase two of the investigation began after the interview and transcripts were coded, and analyzed for thematic development. The findings that emerged from Naturalistic Inquiry were used to develop a survey for supportive evidence regarding the teachers' perceptions. The survey results were statistically analyzed to determine how teaching practices were impacted as a result of involvement with the professional development model. The questions included both Likert scaled responses to determine if teachers were impacted and open-ended questions to determine if any new information would surface outside an interview format. No new information surfaced in the open-ended responses. Three months after statistical analysis was completed, random classroom observations of the teachers were conducted to look for demonstrations of change.

West Texas Participant Profiles

The program participants consisted of twelve rural public secondary teachers from South to Upper West Texas school districts. The chart following the narrative may help with some of the descriptors. One small town college lower division engineering professor and a large city informal science educator also participated in the summer institute. Three teachers have positions at the same high school, and two different teachers co-teach their courses at another high school. The remaining seven secondary teachers were the single teacher that participated from their respective schools and districts. Four of these seven teachers are middle school science teachers. Seven of the twelve secondary teachers coach sports in addition to their duties as science teachers. Three out of the eight high school teachers teach chemistry, the remaining teach first year biology, and/or a biology related elective. There are nine females and five male teachers in this group ranging in ages from late twenties to late fifties.

Teacher Name	Teach Level	Years of Experience	Course Teaching Currently	Degree Major	Member Team	Gender
Naomi	MS	6	Multi level Science	Kinesiology	N	F
Rachel	MS	11	Life/Earth Science	Home Economics	N	F
Chelsea	MS	25	Life Science	Biology	N	F
Barbara	MS	9	Life Science	Bio	N	F
Shirley	HS	9	Chemistry	Psychology	Y	F
Sandy	HS	4	Chemistry	Political Science	N	F
Bill	HS	8	Chemistry	Kinesiology	N	M
Karen	HS	8	Biology	Biology	Y	F
Cindy	HS	18	Environmental	Biology	Y	F
John	HS	9	Biology	Biology	Y	M
Karl	HS	14	Biology	Kinesiology	Y	M
Steven	HS	12	Biology	Kinesiology	N	M
Betsy	HE	15	Integrated Science	PhD Science Ed	N	F
Randy	Inform	4	Aquatic Studies	MS Entomology	N	M

New Mexico Participant Profiles

Eight teachers participated in the New Mexico course. Six teachers were from the Albuquerque area. One teacher was from rural New Mexico and another from rural Colorado. One teacher has a master's degree in geology, but currently teaches technology. Two other teachers had strong backgrounds in geology, one holds a BS and the other is working on a Masters, with a BS in general studies. One currently teaches general science courses in high school, the other teaches alternative certification courses. Three teachers have degrees in Biology. Of this group, two teachers currently teach middle school general science courses. One of the biology degreed teachers currently teaches biology, chemistry, and earth sciences in a small rural high school in addition to teacher preparation courses at the local college. Another teacher has a degree in history with some college science courses and teaches in an alternative high school for non-traditional students. This high school uses an interdisciplinary curriculum approach, and this teacher uses science content to thematically string together all the students' curricular needs. Two teachers received alternative certification and have business backgrounds. One has a degree in chemistry while the other holds a degree in biology. One of these teachers teaches all the science courses in a small rural school. The other teaches gifted and talented students in a middle school setting where the science disciplines are rotated every nine weeks.

Teacher Name	Level of Teaching	Years of Experience	Course Teaching Currently	Degree Held Major	Member of School Team	Gender
Joshua	MS	3	General Science	Biology	N	M
Rainee	HS	14	Integrated Science	History	N	F
Stacey	HS	22	General Science	Gen Studies	N	F

Bryant	MS	35	Technology	Geology	N	M
Mitch	HS	2	Biology, Chemistry, Earth	Chemistry	N	M
Scott	MS	2	Bio,Chemistry, Earth, PS	Biology	N	M
Casey	HS/HE	18	Biology, Earth, Education	Biology	N	F
Jolyn	HS/HE	5	Geology/Education	Geology	N	F

Participant Teacher Certification

All twenty-two teachers are state certified to teach secondary science courses. Eight teachers are teaching outside their specialized area. Three high school teachers do not have at least a minor in science in their undergraduate studies, and have learned most of their science content in professional development programs. The middle school teachers have taken a varying degree of college science courses with a mixture of science professional development programs.

Findings

Two important findings emerged as a result of this study. Both qualitative and quantitative data found that teaching practices were impacted and teachers' science content knowledge improved as a result of their involvement with the intensive model. It was found that the teachers teaching practices were highly impacted and teachers' science content knowledge improved significantly.

`Qualitative data was collected, transcribed, and coded for theme development using QSR NUD*IST Software (Qualitative Solutions and Research for Non-numerical Unstructured Data Indexing Searching and Theorizing; Sage Publications, 1995). Two overall themes regarding teaching practices emerged from this investigation. These two themes were:

- Increase in student centered instruction
- Increase in student learning expectations

After qualitative data were analyzed, the quantitative tool was designed, data was collected and analyzed, using a t-test, with $n=16$ and $p<.001$.

Increase in Student Centered Instruction

Analysis of the survey completed after the teachers completed the professional development model indicates that teachers shifted their teaching practices from more teacher directed lessons and classrooms to more student centered learning environments. The set of questions used to support the teachers' perceptions were divided into two categories with three teaching practices. The teacher-centered indicators used were 1) teacher directed lessons, 2) lecturing, and 3) prescribed lab activities. The student-centered indicators used were 1) relevant learning, 2) student-centered lessons, and 3) constructivist activities. Teachers were then asked to rate the amount of time they

engaged in these activities both before and after their participation in the intensive field science professional development model.

All but one teacher increased the amount of instruction time on student centered instruction as compared to their past teaching experiences. One teacher said that he did not increase the amount of student centered activities because he already utilized student centered projects in his classroom instruction almost all the time prior to his involvement in the professional development model.

Specific comments emerged from teacher interviews indicating that new involvement in student centered instruction was increasing. Various student centered instruction practices were identified as a result of the teacher interviews, including:

a. Less lecture time
b. Less prescriptive lab activities
c. Increase in long term thematic projects
d. Less dependency on textbook curriculum
e. Increase use of the local environment
f. Increase in cooperative learning activities

Less Lecture Time

During the teacher interviews, conversation emerged referring not only to their changes in teaching practice from teacher directed lectures, but in observable behavioral changes in their students. Several teachers commented that they felt they were not working as hard in the classroom because they were not lecturing. Instead, they noticed that their students were working much harder.

> Stacey, "I don't feel like I'm working as hard in the classroom, but my students are very busy, active, talking, and I love it! I think I still lecture too much, but I am working on it."
>
> Karl, "I almost feel guilty teaching as a facilitator because I am not doing all the work anymore. My kids are so much busier. They like coming into class and talking about science stuff."
>
> John, "The biggest thing for me was letting the kids take over. I found that I really enjoy letting them lead the discussions."

Data collected from the survey instrument showed that teachers did decline in the amount of time they said they spent lecturing after their professional development program. The largest impact was from those teachers reporting that they extensively used lectures from 12.5% before their involvement to 0% afterwards. This downward shift in the amount of time in lectures continued to surface in the data as shown Table 4. (n=16) The sliding scale is from extensive, often, occasionally, to never.

Table 4. Lecturing frequency before and after professional development.

Lecturing		
	Before	*After*
Extensively	12.5%	0.0%
Often	12.5%	18.8%
Occasionally	56.3%	50.0%
Never	18.8%	31.3%

Less Prescriptive Lab Activities

During emergent teacher interviews much discussion arose in regards to the new activities that students were engaged with. The teachers openly discussed the types of preparation necessary to facilitate student centered lab activities. Most teachers reported the excitement that the students brought to the classroom as a result of their constructing their own knowledge.

> John, "I found that it takes a lot more of my time outside the classroom to make certain the kids have all the things they need for an open-ended lab. I have found myself wandering out in the pasture at 5:00 in the morning collecting native grasses for them to work with."
>
> Barbara, " My kids loved getting to chose their own insects to use in their projects. I did not tell them exactly how to do things, but told them the parts of the project that they must include. I found out that they did better because they got to chose different insects."
>
> Karen, "During our recycling unit, I told my kids they had to bring in something to include the interdependence of life in their project from what ever. It was really neat to see the things they brought to school for their classmates to make connections."

While most teachers gave examples about open-ended activities in their classroom during interviews, the descriptive statistical data indicates that not all teachers were engaged in these activities. Specifically, when teachers were asked to report their frequency of using prescribed lab activities with their students the number unexpectedly increased from 43.8% engaged occasionally before professional development to 56.3% afterwards. Conversely, the frequency of constructivist lab activities increased from 6.3% saying often before to a 68.8% afterwards. Table 5 outlines this dilemma.

Table 5. Comparison of frequency of prescribed and constructivist activities before and after professional development.

Prescribed Lab Activities			Constructivist Lab Activities		
	Before	*After*		*Before*	*After*
never	0.0%	0.0%	never	12.5%	0.0%
occasionally	43.8%	56.3%	occasionally	75.0%	18.8%
often	50.0%	31.3%	often	6.3%	68.8%
extensively	6.3%	12.5%	extensively	6.3%	12.5%

Relevant Learning and Student Centered Indicators

The last four indicators that developed under the theme of student centered instruction were increase in long term thematic projects, less dependency on textbook curriculum, increase use of the local environment, and increase in cooperative learning activities. These indicators emerged as a result of theme analysis. Survey results showed not all teachers were engaged in each indicator, but the descriptive statistics determined, all teachers were engaged in many of these indicators. The teacher quotes utilized below exemplify the variances teachers brought to their instruction to make relevant connections with their students.

The teachers perceived their teaching practices were much more student centered and provided relevant learning opportunities for their students after their program involvement. The data outlined in Table 6 shows that the professional development had a high impact in these areas.

Table 6. Comparison of frequency of relevant and student centered learning before and after the professional development program.

Relevant Learning			Student Centered		
	Before	*After*		*Before*	*After*
never	0.0%	0.0%	never	0.0%	0.0%
occasionally	18.8%	6.3%	occasionally	50.0%	0.0%
often	75.0%	50.0%	often	50.0%	93.8%
extensively	6.3%	43.8%	extensively	0.0%	6.3%

Increase in Long Term Thematic Projects

> Rainee, " I had my students use constancy and change to develop a six week project. After the September 11 tragedy, the kids told me everything is undergoing change and we really did think it was constant. Their projects reflected their understandings in the presentations that they did. I plan on doing more projects like this."

Cindy, "I found that by doing thematic projects around the interdependence of life that the kids made more connections than what my past students had done. I am going to do more long projects this year than before because it helps the kids so much more."

Rachel, "I've never done anything like this before. But, in south Texas we don't have any water. So, my kids and I put in a pond. We're using the pond to study the interdependence of life. It's much better than using the book."

Less Dependency on Textbook Curriculum

Bill, "I threw my textbook in the garbage can in front of the kids one day and said, I don't care what the book says, what do you think."

Steven, "I told my students at the beginning of the year that their textbook is a reference tool and that we would only use it to help us understand things. But we may not read the all of it. What I have found that by using the textbook like that, is the kids are jumping all through the book to look for stuff. They find one thing on page 5, another on page 205, it's really neat."

Increase Use of the Local Environment

Karen, "We made a nature trail around the campus and our students are using that to teach younger kids."

Rachel, "Well the kids have used the pond to figure things out. We studied the affects of plants that I planted around the pond versus ones that just showed up. I was great watching the kids discover this."

Jolyn, "I went back to some of the same field spots we went to this summer. It is so much better than using the textbook. The kids can really see things because it is right there."

Joshua, "We don't have money for field trips, but I used our campus to help the kids make the geology connections. They began to see things that I had not thought about before about the soil and stuff."

Shirley, "We are trying to make students gradually realize how human behavior affect the Earth's capacity to sustain life. We are pursuing policies and issues as they become interested in them. They are sampling the local waterways and collecting garbage from the sites. We are having them analyze the garbage to interpret where it came from, and all."

Stacey, "Each topic is introduced through New Mexico geology and then the kids expand that to a global picture."

Increase in Cooperative Learning Activities

Naomi, "My kids are doing so much more in groups, now. They are learning more, but it's not always what I was hoping they would learn."

Stacey, "The first time I had them work in inquiry groups, I thought it was a disaster. They were so noisy. I learned that the noise was okay, and I also learned how to set limits to make sure they did the activities. They are learning so much more from each other than they ever got from my lectures."

Increase in Student Learning Expectations

All the teachers reported during their interviews that their student learning expectations and achievement had increased as a result of teaching their science curriculum around a thematic benchmark. Statistically, 56.3% of the teachers strongly agreed that they believed their students had a deeper understanding of science content as a result of their thematic teaching approaches and 31.3% agreed. The teachers identified this increase in their expectations through the variety of observations listed below. Although not all teachers commented on all indicators, statistical data showed that the teachers' overall perceptions of their students' abilities did improve.

a. Students made meaningful connections
b. Students used their own examples and evidence to support science issues
c. Students learned science content faster with deep understanding

Students Made Meaningful Connections

The comments below emphasized that teachers found their students were making unexpected content connections that were meaningful and relevant to the students' lives. Teachers reported that many of these connections resulted during student group discussions and small group activities.

John, "I was amazed at how much prior knowledge the kids had. In the past, I didn't think my kids knew anything. My mistake was not using inquiry methods sooner, I just didn't trust myself or the kids. I didn't think it would work. But, the kids are really learning to make connections."

Jolyn, "I was surprised with the examples they brought to the classroom. It was things I never would have thought of, quality stuff."

Karl, "I was having trouble getting the kids to think on their own at first. But, now they are always coming up with new ideas and ways to think of stuff. They make lots of connections to their everyday life."

Joshua, "My kids were going home and getting their parents to help them with their activities. I was really impressed that my bilingual students had such good ideas to add to discussions. They really know more about their environment than me. They were telling me how to use plants and stuff."

Casey, "I found it is so much easier to connect all the state science standards when teaching constancy and change. I had no idea how fragmented I had been teaching. The kids are teaching me so much."

Students Used Their Own Examples and Evidence to Support Science Issues

Students demonstrated the ability to use supportive examples and evidence to support science issues that were not cited by the teachers or the textbook. The teacher remarks below are a small sampling of the numerous ideas reported that students incorporated in their daily studies.

Rainee, "I didn't use a science textbook to teach constancy and change. So, the kids had to get on the internet and find examples to support what we were seeing at the field sites. They brought up stuff that I did not learn this summer, but I could see how their examples were right."

John, "I asked the kids to bring in stuff they collected in their backyards or pastures to study in the lab activities. I thought they brought in good stuff to help the rest of us learn."

Casey, "One of my students brought in what is known as Indian tears for a rock example. I wasn't sure if it was right, but I found out the kid was correct. I didn't know what kind of rock this was, but he did."

Students Learned Science Content Faster With Deep Understanding

Teachers found that their students were learning science content knowledge faster and with a deeper understanding than they had in the past. Many teachers shared comments about how much the students were learning ~~that~~ what was not in their textbook. Most teachers found that the students were learning more science content from new teaching practices than they could have received from their past lectures.

Steven, "The kids are learning a lot more and faster than my past classes. They remember more stuff, too."

Stacey, "The kids are learning more because I don't talk as much. They are learning faster and they use the science words in the right context"

Shirley, "The students are bringing up stuff that we learned during the first part of the unit. I don't remember that happening before."

John, "You may be upset with me for saying this, but I did not think much about inquiry teaching before this summer. I kept thinking, yeah…people say it's supposed to work. But, you guys wouldn't let up. So, I tried it. I have been amazed at how much better the students are doing. I mean, their grades are almost twice better than what they were in the past. Not just in discussions, but on all their assessments. I can't ever imagine teaching the way I did before."

Rainee, "My students are remembering things we talked about months ago. That's remarkable, they really understand this stuff."

Sandy, "I don't lecture as often and the students are learning more from each other. They seem to be able to understand one another better than they understand me. "

The survey administered also showed that the teachers' perceived their students' achievement had increased. Teachers were asked to respond to the first statement: "My current students have demonstrated higher achievement than students in the past." If the respondents did not choose disagree, they were then asked to complete a series of "yes, no" statements to help identify areas where student achievement had increased. Table 7 outlines identified areas. Only two teachers responded that student achievement had not improved. (n=16)

Table 7. Increased area of student achievement as reported by teachers.

Higher Student Achievement		**Areas Identified**		
			Yes	*No*
strongly disagree	6.3%	discussions	81.3%	18.8%
disagree	6.3%	presentations	68.8%	31.3%
agree	50.0%	written	62.5%	37.5%
strongly agree	37.5%	projects	81.3%	18.8%
		tests	37.5%	62.5%

"As far as grades are concerned, the student centered model has resulted in a much higher GPA in my classroom" (anonymous survey response).

Increase in Teacher Content Knowledge

Information collected from the survey was analyzed to determine if teachers' content knowledge had improved. Data was also collected to determine if teachers need more instruction on certain items to assist with student improvement. Separate analyses were developed to show how teachers' science content knowledge and teachers' pedagogical knowledge were impacted by the professional development model.

Teachers' Science Content Knowledge

The teachers overwhelmingly agreed that their science content knowledge had improved as a result of their involvement with the intensive field science professional development model. When teachers were asked if their experience with the intensive model had increased their science content knowledge, 87.5% of the teachers either agreed or strongly agreed. More than half of the teachers agreed that they had a deeper understanding of either "interdependence of life" or "constancy and change" as a result of the summer institute. Additionally, when asked if they observed that their students now had a deeper understanding of science as a result of their knowledge about the thematic benchmarks, more than half reported that they strongly agreed and one-third reported that they agreed. The summarized chart (Table 8) reflects the teachers' overall improvement in science content knowledge.

Table 8 Teachers reflections on increased science content knowledge and topic understanding.

Increased Science Content		Increased Topic Understanding	
strongly disagree	0.0%	strongly disagree	0.0%
disagree	0.0%	disagree	12.5%
uncertain	6.3%	uncertain	31.3%
agree	50.0%	agree	56.3%
strongly agree	37.5%	strongly agree	0.0%

"Would love to continue outdoor teacher learning, or field experience to keep my love of science charged" (anonymous survey response).

Teachers' Pedagogical Content Knowledge

After some of the teachers began implementing their action plans into their classrooms, conversation emerged during their interviews indicating that the teachers may not have enough prior knowledge or experiences to completely immerse their students in open-ended activities. Therefore, questions were developed to determine if teachers needed more pedagogical content knowledge in constructivist activities. Only 50% of the teachers responded that the professional development model improved their understanding of project-based learning and student centered activities. However, 62% of the teachers agreed that their role in the classroom had changed from "teacher" to facilitator "learner", while 37.5% strongly agreed.

Teachers were also asked an open-ended question on the survey about their future needs for this professional development model and the anonymous responses below exemplify that teachers need more practical experiences with project-based, student centered activities.

> "Additional field work ideas and lab ideas would be beneficial."
>
> "More hands on field or lab work would be great. Or maybe more project oriented information."
>
> "Go back to Dolan Falls and do field work with trained people."
>
> "Concept-based curriculum design field experiences in the Albuquerque area related to the Rio Grande, geology, and ecosystems."
>
> (anonymous survey responses)

Discussion

The purpose of this investigation was to design a professional development model utilizing as many effective teaching practices as outlined in current education research. In addition, three unique, yet critical components were placed into the design to enhance relevant learning for the teachers. These critical issues were 1) authentic contextual settings to improve both science content and pedagogical knowledge, 2) the development of strong teacher learning communities, and 3) long-term involvement with science educators from K-12, professional developers, higher education faculty, and research.

The field experiences provided teachers with opportunities that few encounter in their college preparation. As educators, we realize that diverse learners benefit greatly from using their surroundings as a learning tool. However, as professional developers, we fail to offer ample programs to assist teachers with these experiences for their students. Addressing the teachers' contextual setting in our professional development programs not only validates the importance of schools, but also engages faculty of higher education in the elimination of the disparity between "teachers just need to know more" and "teachers need to learn how to teach the things they know."

Intensive Field Science Professional Development Model for Secondary Science Teachers to another consortia director.

> "Improving teachers' science content is a critical step toward improving their instruction. Yet rarely do teachers have opportunities to learn and

> connect content expertise with the instructional expertise required to teach secondary students. Working closely with university faculty from the sciences, this model was designed to improve teachers' content understandings and instructional approaches at the same time. These programs are located in field research settings and have covered the scientific inquiry process from data collection to interpretation of results. In addition, teachers design instructional and assessment activities that bring the main concepts alive in their classroom, test them in the follow-up sessions, and share their learnings with one another" (Stephen Marble, SCIMAST Program Director).

Developing strong teacher learning communities was a major concern in the design. Just like a classroom of students, the make up of personalities and perceived participant roles, sets the stage for personal interactions. Although both programs included a one-week intensive study in the summer, there were differences in the execution of the programs to meet the needs of the field sites and the science professors. The West Texas field site is very remote, and the teachers were housed over night at a field station. The teachers in the New Mexico program either lived in the surrounding Albuquerque area or stayed in nearby hotels. Due to the lack of group overnight housing, this may have set limitations on the development of the teacher learning community. However, teachers' responses indicated that the teacher support system in both programs was adequate to help them get through the insecurities associated with changing one's behavior.

> "This (program) also opened my eyes up to more science information by having the buddy system and getting information from each member of our group on web sites, books, programs, etc..."
>
> "Hearing suggestions from other teachers helped."
>
> "I really enjoyed the discussion time in the afternoons!"
>
> " Interaction with other members of the science teaching profession was the most beneficial part of the institute."
>
> "I will miss the list server - can we keep it past March?"
>
> "It takes a lot of time and great effort to change your lessons and the way you teach."

The long-term involvement from both facilitators and teacher participants was pivotal in changing belief systems. This commitment not only changed the teachers' belief systems about themselves and their students; it also changed the belief systems of the professors and the education specialist. The professors became enthralled in the education jargon that was utilized in the afternoon teacher learning sessions in the summer institutes and quickly found themselves wanting to learn more. The education specialist learned to become a mediator between two groups of people with common goals, but uncommon language and was challenged to find common misconceptions

among them to help develop collegiality. Professors also realized that the base science content knowledge of teachers is very broad, as some participants have Masters' degrees in their subject areas, and other teachers have no formal science training. The facilitators were also able to recognize that more open-ended student centered activities need to be in teachers' college experiences and professional development programs for in-service teachers as a result of this gap in knowledge. The outcome of a reciprocal learning process from professor to teacher to researcher was one of the most rewarding discoveries in this investigation. As one teacher participant stated in the open-ended response on the survey,

"No one can be a true teacher if they don't learn from their students."

References:

Ball, D. and McDiarmid, G. (1997). The subject matter preparation of teachers. Handbook for Research on Teacher Education. New York: Macmillan

Bybee, R. and Loucks-Horsley, S. (2001). National Science Education Standards as a Catalyst for Change: The Essential Role of Professional Development. In Rhoton, J. and bowers, P. (Eds.), Professional development planning and design. Arlington, VA: NSTA Press.

Gadsden, T. and Roempler, K. S. (2001). Using ENC and ERIC to Plan for Professional Development. In Rhoton, J. and bowers, P. (Eds.), Professional development planning and design. Arlington, VA: NSTA Press.

Rutherford, J. and Ahlgren, A. (1990). Science for all Americans. New York: Oxford University Press.

Seibert, E. and McIntosh, W. editors (2001) College Pathways to the Science Education Standards. Arlington, Va: NSTA Press.

Thompson, C. and Zueli, J. (1999). The frame and the tapestry: Standards-based reform and professional development. In G. Sykes (Ed.), Teaching as the learning profession: handbook of policy and practice. San Francisco: Jossey-Bass.

Van Driel, J., Bejaard, D. and Verloop, N. (2001) Professional development and reform in Science education: the role of teachers' practical knowledge. Journal of Research in Science Teachng. 38:2 pp 137-158.

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Signature: Nikki L. Hanegan, Ph.D.

Printed Name/Position/Title: Dr. Nikki L. Hanegan

Organization/Address: SEDL / BYU

Telephone: 800.476.1861

FAX:

E-Mail Address: nhanegan@sedl.org

Date: 3/26/03